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Status and Trends of the U.S. Agricultural AD Market

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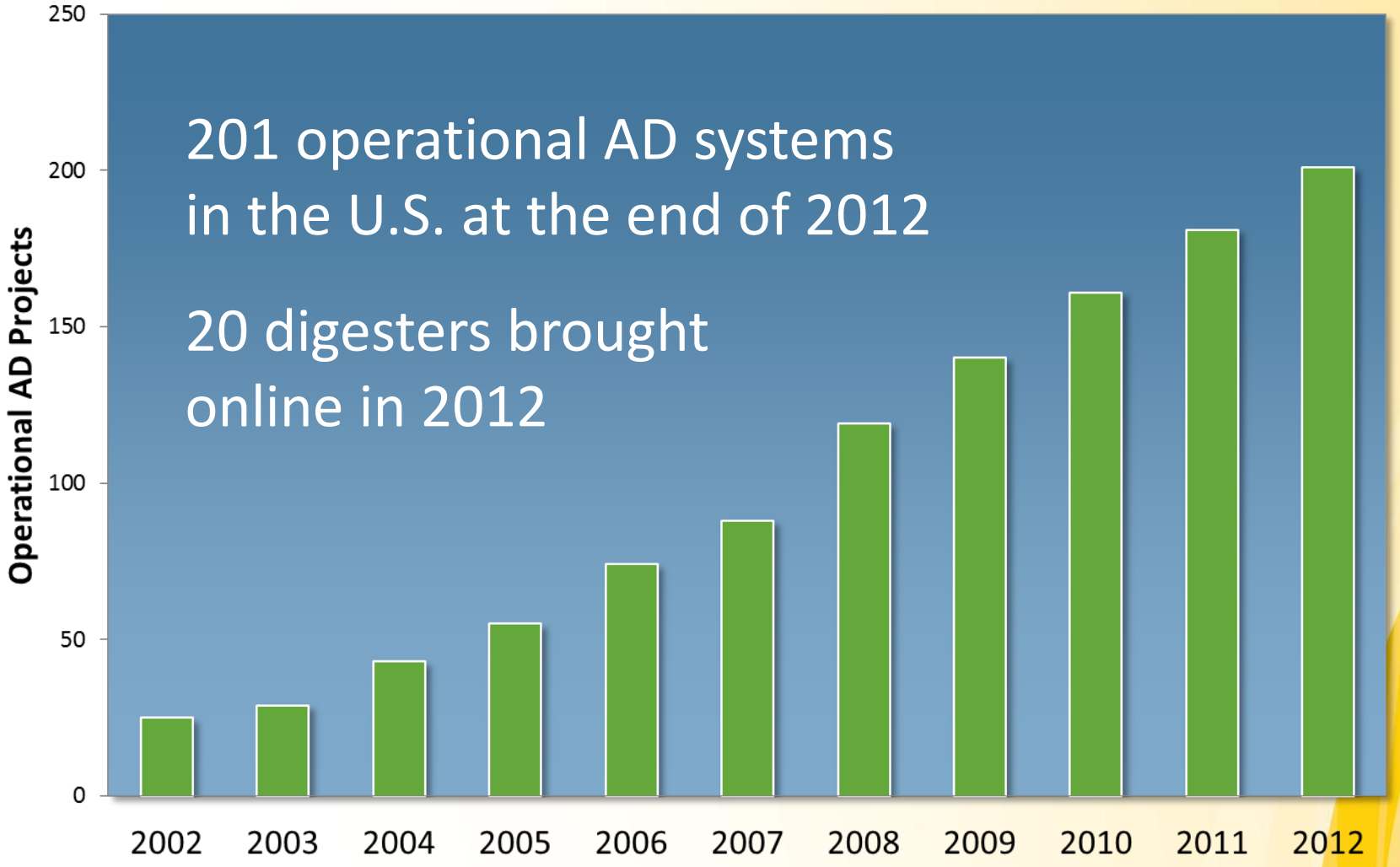
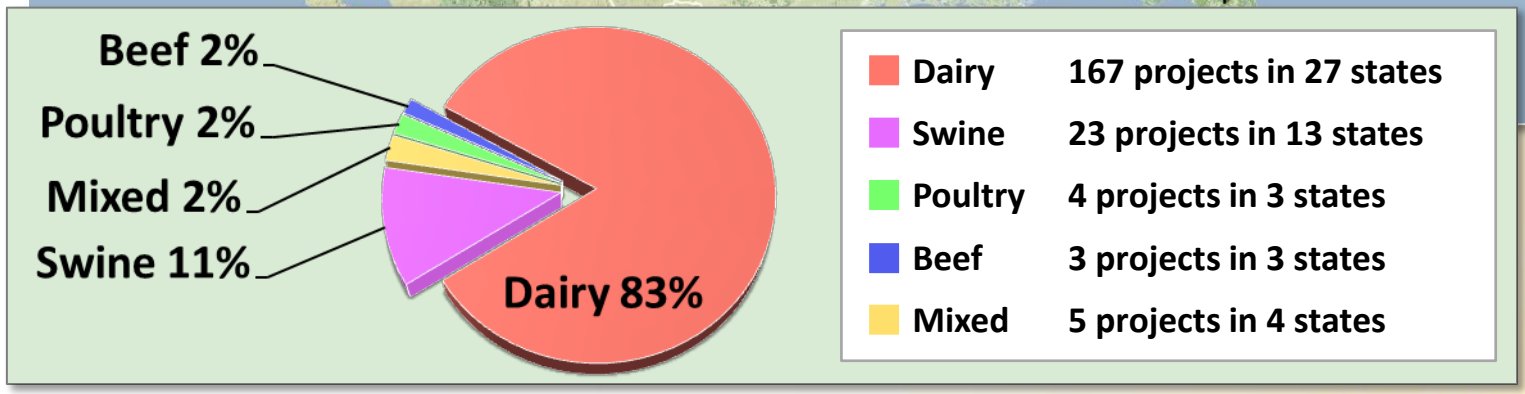
AD Systems Are Growing in the U.S.



AD Systems Operate on Farms in 34 States &



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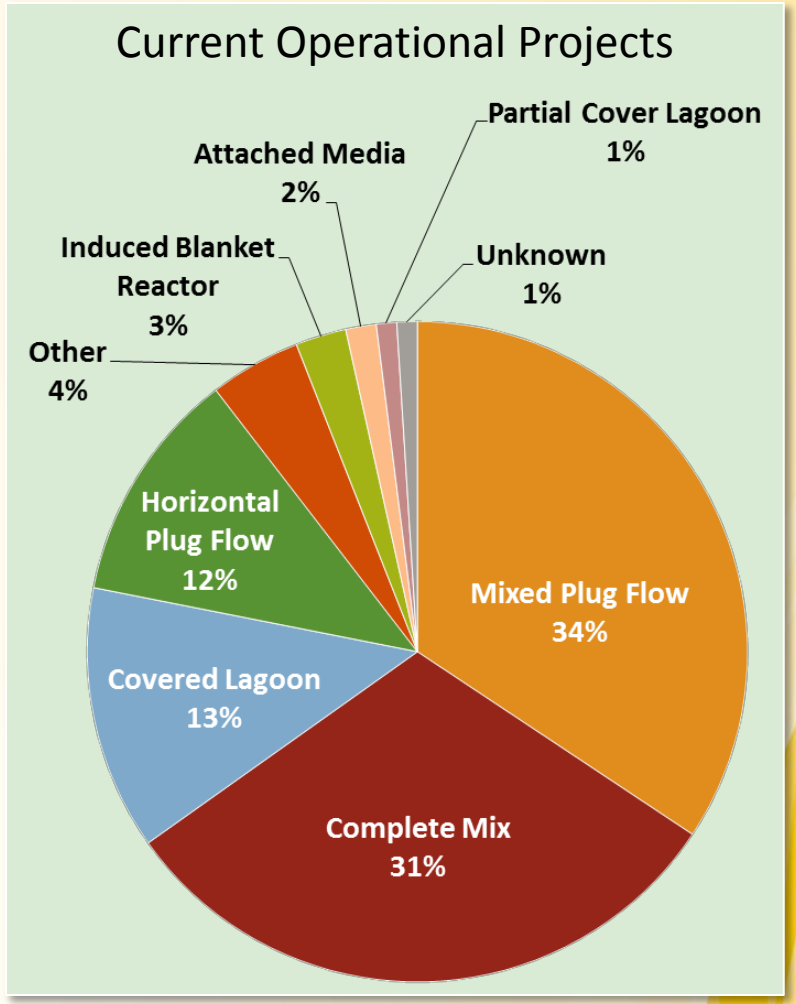
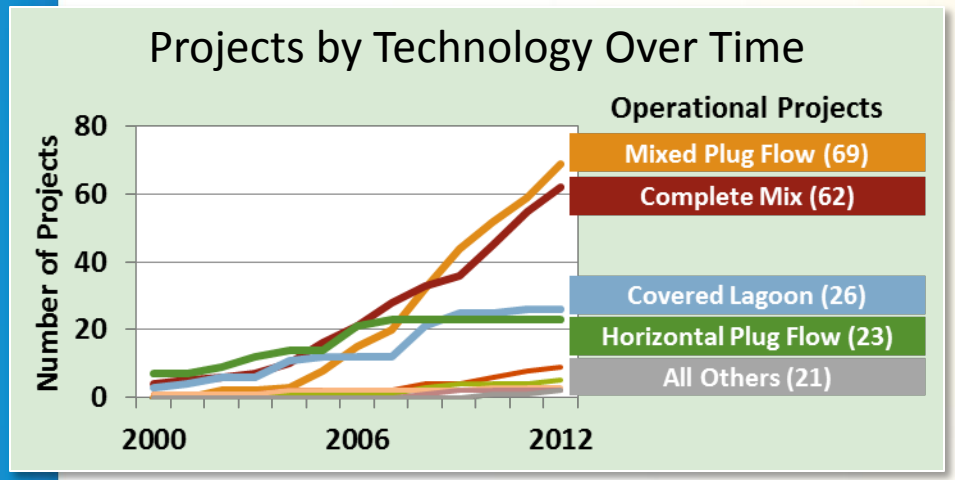
20 AD Projects Came Online in 2012 &

State	Total
Iowa	1 (mixed)
Idaho	1 (dairy)
Maine	1 (dairy)
Missouri	1 (beef)
North Carolina	1 (swine)
New York	2 (dairy)
Ohio	3 (dairy)
Oregon	1 (dairy)
Pennsylvania	1 (dairy)
Vermont	1 (dairy)
Washington	2 (dairy)
Wisconsin	5 (dairy)

AD Systems Use Several Technologies &

- **40 percent of new projects are mixed plug flow**
- **Mixed plug flow and complete mix continue to be dominant technologies**

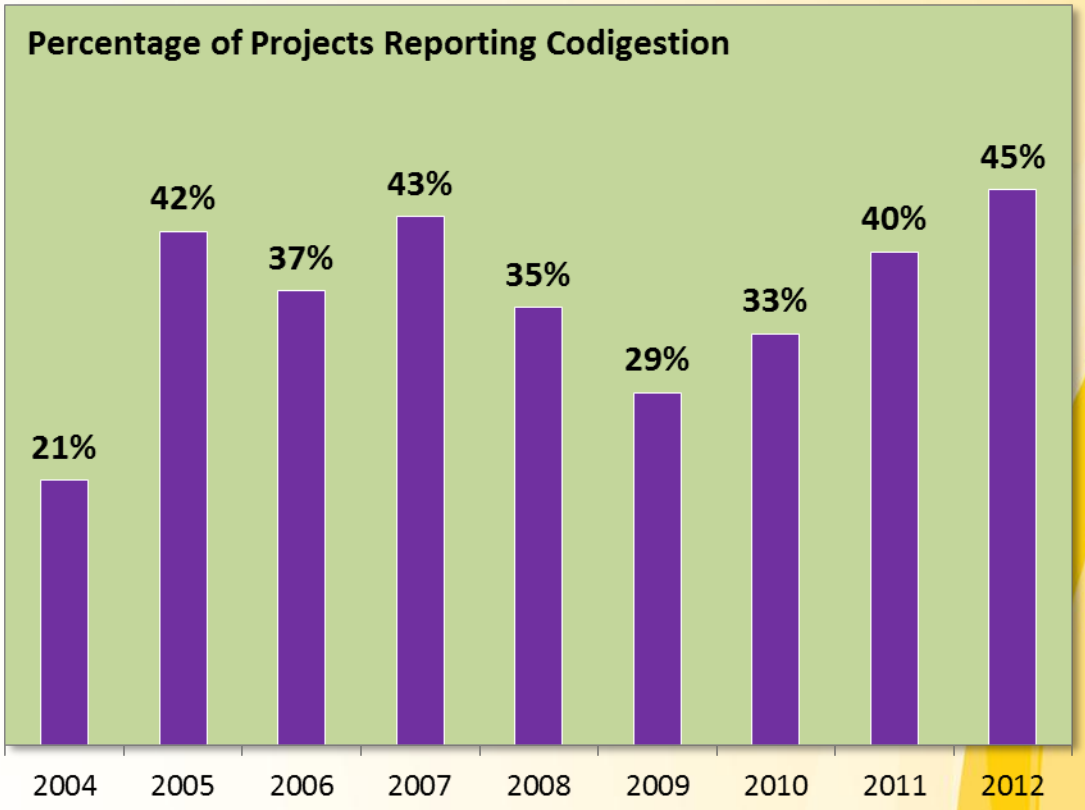




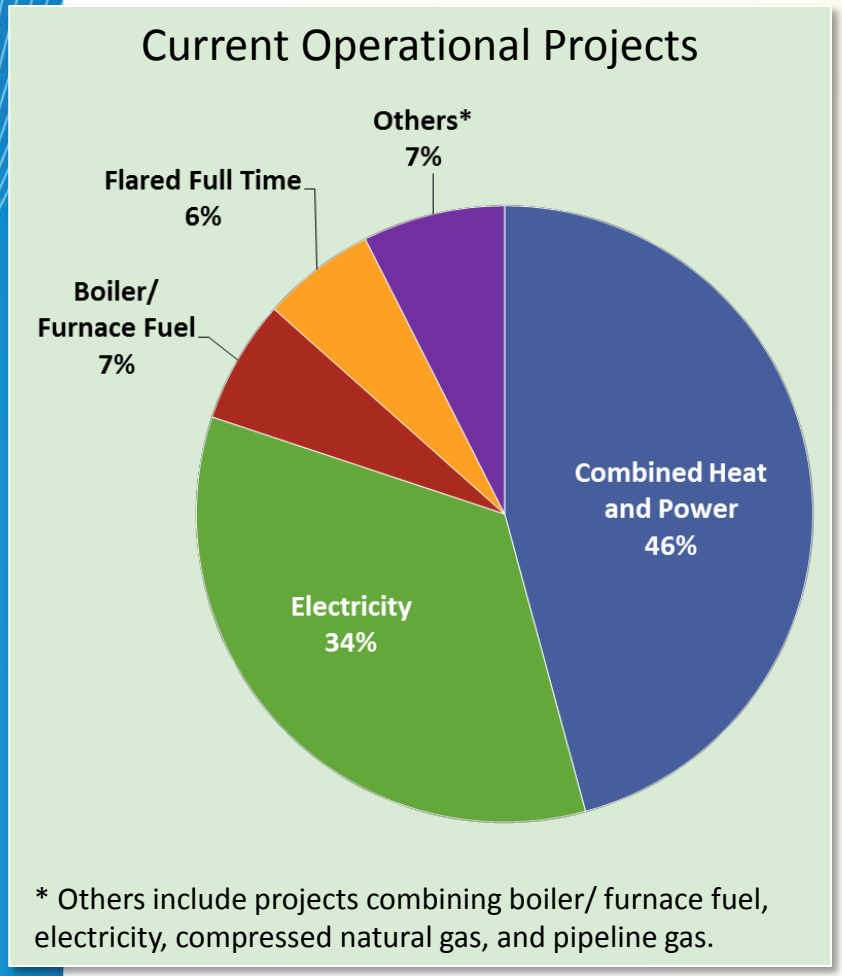
Codigestion Is Becoming More Common &

- **Most operational systems use only livestock manure**
- **Based on reporting, codigestion projects are trending higher as a percentage**

Examples of Codigestion Wastes
Food waste
Organic wastes
Wastewater
Substrates
Whey
Grease and other restaurant waste
Off-farm waste
Food industry waste
Mixed biomass
Crude glycerine
Wastes from surrounding community

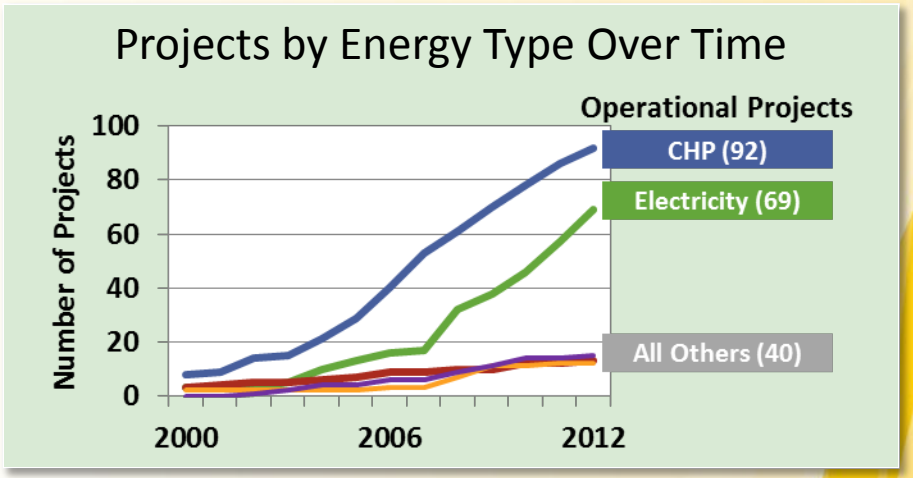


Biogas Used Primarily for Electricity and Combined Heat and Power (CHP)

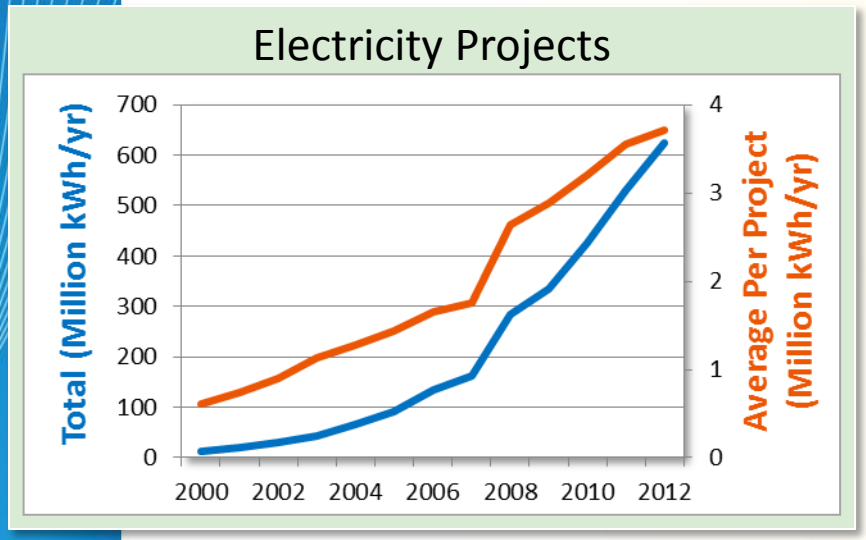


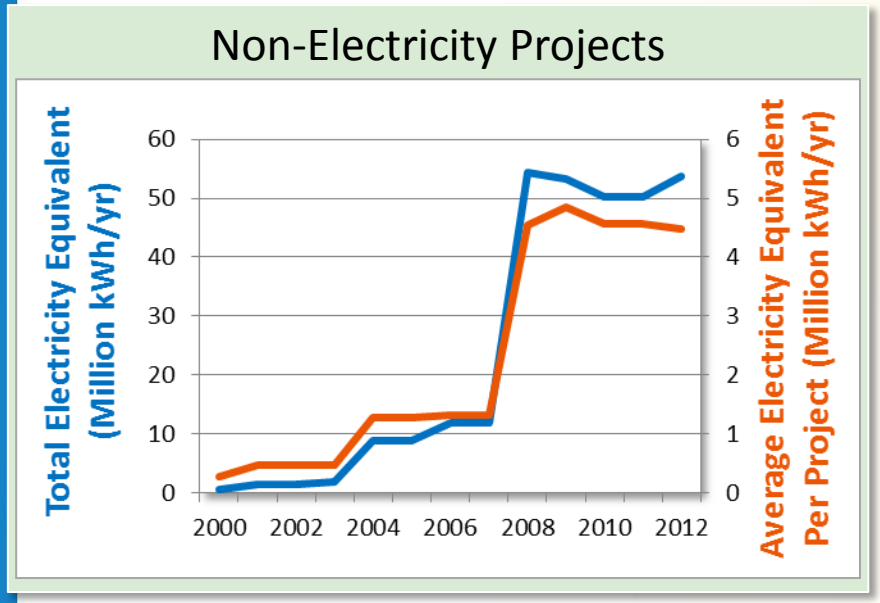
* Others include projects combining boiler/ furnace fuel, electricity, compressed natural gas, and pipeline gas.

- **CHP continues to be the most common end use**
- **Biogas end use for most new projects in 2012 is electricity (60 percent)**



AD Systems Produce Significant Energy Today &



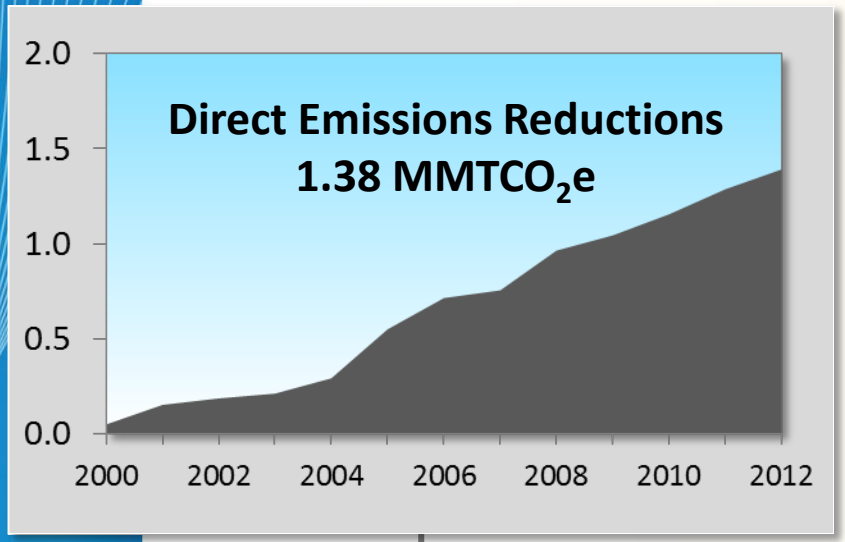


- **>600 million kWh/yr is generated by operational AD projects**
- **In 2012, 168 electricity projects generated an average of 3.7 million kWh/yr each**
- **Non-electricity projects produced the equivalent of >53 million kWh/yr**

Digester Byproducts Add Value &

- Liquid effluent is used as fertilizer to reduce the purchase of commercial fertilizers
- Solid effluents are commonly used for bedding, potting soil, soil amendments, and biodegradable pots
- Emerging commercial uses for effluent solids include building materials such as deck boards
- Because effluent solids are very malleable, there are many opportunities for other uses

AD Systems Help the Environment Directly &



- **AD systems capture and destroy methane, a potent greenhouse gas**
- **In 2012, AD systems directly reduced emissions by 1.38 $MMTCO_2e$**

Direct Emissions Reductions Equivalent to:

CO_2 emissions from burning 5,900 railcars of coal

or

Carbon sequestered by +35,000,000 tree seedlings grown for 10 years

or

CO_2 emissions from electricity use of 206,587 U.S. homes in one year

Equivalency results calculated at www.epa.gov/cleanenergy/energy-resources/calculator.html &

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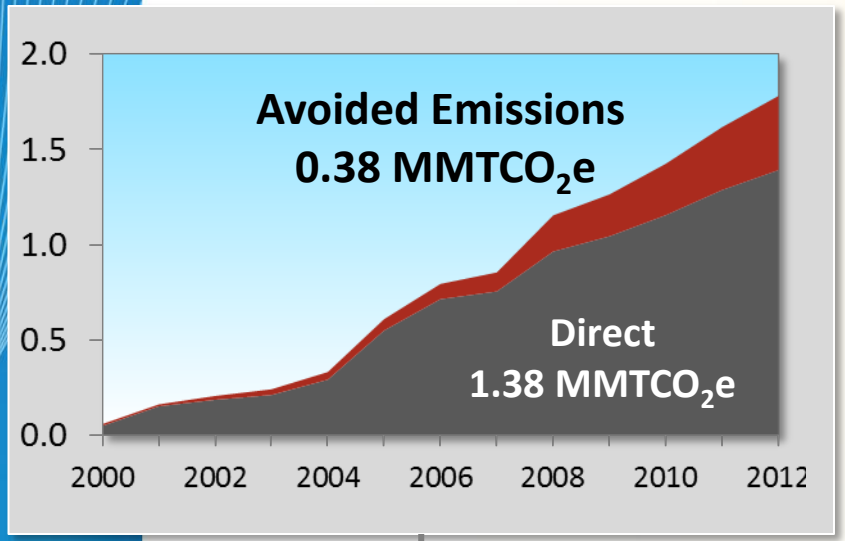
Indirect Benefits Also Are Significant &



- **Energy generated from AD systems displaces fossil fuels, avoiding fossil fuel-based emissions**
- **In 2012, 380,000 metric tons of CO_2e was avoided**
- **1.76 $MMTCO_2e$ total emissions reduced or avoided in 2012**

Avoided Emissions Equivalent to:

Carbon sequestered by 311,475 acres of U.S. forests in one year

or

CO_2 emissions from 883,721 barrels of oil consumed

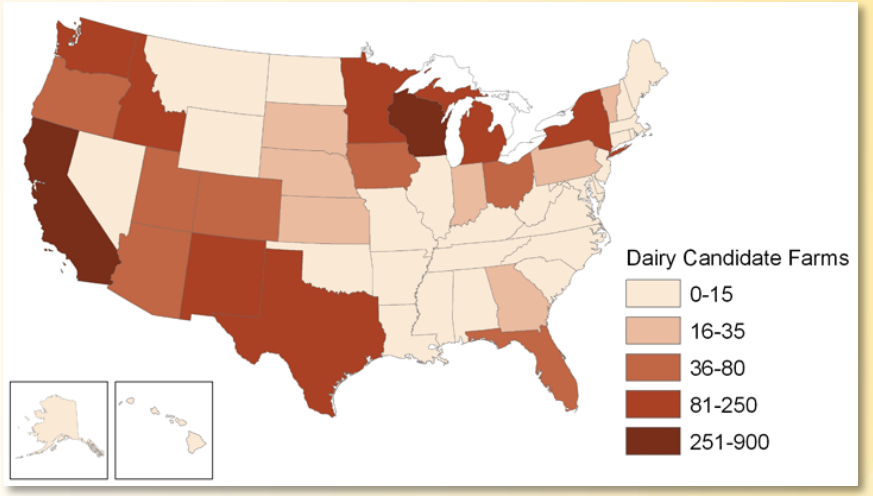
or

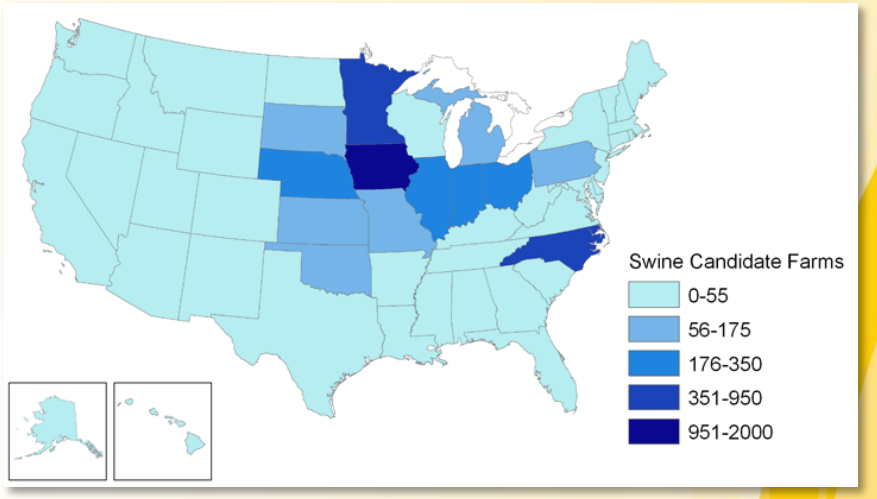
CO_2 emissions from 42,600,897 gallons of gasoline consumed

Equivalency results calculated at www.epa.gov/cleanenergy/energy-resources/calculator.html &

Current Market Penetration is Low &

- **<2% of dairy and swine operations in the United States have operational AD systems**
- **Electricity generation potential exceeds 13,000,000 MWh/year (enough to power nearly 500,000 average American households)***

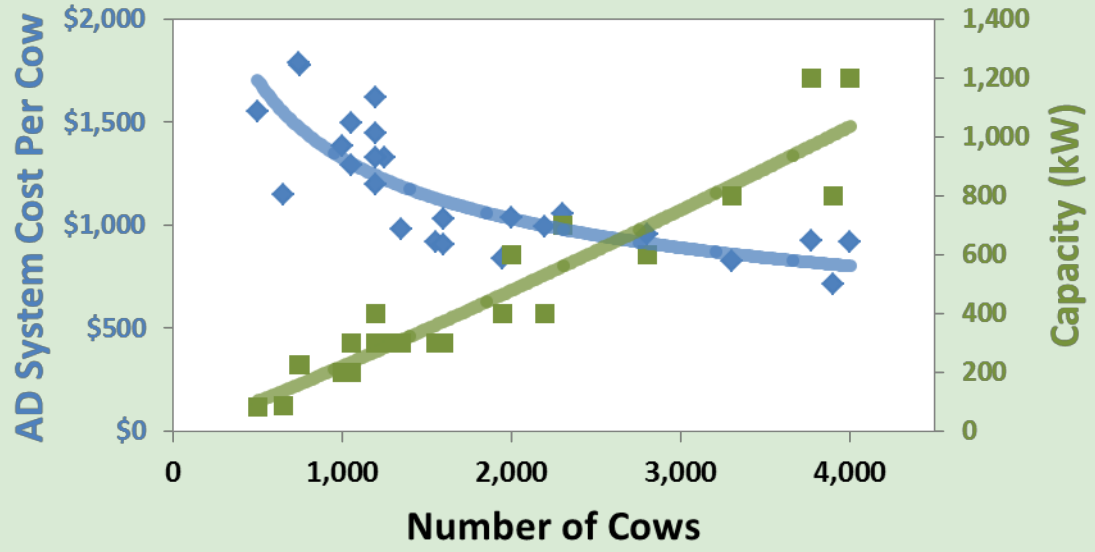




* Average American households use 26.26 MWh & per year, U.S. Energy Information Administration &

Ownership and Operation Approaches Are Evolving

- **Most are owned and operated by the farm**
- **Economic barriers at all scales are significant**
  - High CAPEX; low offtake revenue; capital funding availability
- **Technical expertise required for system operation presents challenges for many operations**



In general, AD system costs per cow and overall energy capacity are directly related to the size of the operation

Other Trends and Issues &

- **Technical innovations and tools**
  - New tools are being developed for feasibility assessments
  - Pilot projects for small-scale digesters
- **New project funding models**
- **Policy focus on diverting organic waste from landfills and uses of AD to manage food wastes**
- **Emerging interest in applying AD to address nutrient issues that affect watersheds**
- **Renewed MOU between USDA and Innovative Center for U.S. Dairy** &
  - Calls for the dairy industry to reduce its carbon emissions by 25% by 2020
  - Aspirational goal of +1,000 new AD projects in the next 10 years

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